

What is claimed is:

1. A polishing head for positioning a surface of a substrate against a polishing surface, the polishing head comprising:

5 a carrier;

a subcarrier carried by the carrier and adapted to hold the substrate during a polishing operation; and

10 a retaining ring having an inner edge disposed about the subcarrier and a lower surface in contact with the polishing surface during the polishing operation, the lower surface of the retaining ring having at least one annular recess formed therein to inhibit non-planar polishing of the surface of the substrate.

15 2. A polishing head according to claim 1, wherein the polishing surface comprises a pad of pliant material capable of being deformed by the retaining ring during a polishing operation.

20 3. A polishing head according to claim 2, wherein the at least one annular recess is adapted to reduce a length of time during which the polishing pad is deformed by the retaining as the retaining ring is moved relative to the polishing pad.

25 4. A polishing head according to claim 2, wherein the at least one annular recess is adapted to reduce an area near an edge of the substrate having a lower polishing rate than a center of the substrate due to rebounding of the pad from a deformed condition in a first region near the inner edge of the retaining ring.

30 5. A polishing head according to claim 4, wherein the at least one annular recess is positioned a predetermined distance from the inner edge of the retaining ring, the predetermined distance selected to reduce the area near the edge of the substrate having a lower polishing rate than a center of the substrate due to rebounding of the pad.

6. A polishing head according to claim 5, wherein the predetermined distance is selected based on magnitude of a force applied to the retaining ring during the polishing operation, magnitude of a force applied to the subcarrier during the polishing operation,

or both.

7. A polishing head according to claim 5, wherein the predetermined distance is selected based on a hardness of the pad.

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8. A polishing head according to claim 4, wherein the at least one annular recess has a predetermined depth and a predetermined radial width in the lower surface of the retaining ring selected to reduce the area near the edge of the substrate having a lower polishing rate than a center of the substrate due to rebounding of the pad.

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9. A polishing head according to claim 8, wherein the predetermined depth and the predetermined radial width are selected based on magnitude of a force applied to the retaining ring during the polishing operation, magnitude of a force applied to the subcarrier during the polishing operation, or both.

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10. A polishing head according to claim 8, wherein the predetermined depth and the predetermined radial width are selected based on a hardness of the pad.

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11. A polishing head according to claim 1, wherein the at least one annular recess comprises a groove having a curved cross-sectional area in a plane perpendicular to the lower surface of the retaining ring.

12. A polishing head according to claim 11, wherein the groove comprises a hemispherical cross-sectional area.

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13. A polishing head according to claim 1, wherein the at least one annular recess comprises a plurality of concentric grooves.

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14. A Chemical Mechanical Polishing (CMP) apparatus having a polishing head with a polishing head according to claim 1, the CMP apparatus further comprising:

a chemical dispensing mechanism adapted to dispense chemical onto the polishing surface during the polishing operation; and

a drive mechanism adapted to move the polishing head relative to the polishing

surface during the polishing operation.

15. A method of polishing a substrate having a surface using a polishing apparatus comprising a polishing surface, a carrier having a subcarrier and a retaining ring circumferentially disposed about the subcarrier, the retaining ring having a lower surface with an annular recess formed therein, the method comprising steps of:

positioning the substrate on the subcarrier;

pressing the surface of the substrate and the lower surface of the retaining ring against the polishing surface, deforming the polishing surface under the retaining ring;

10 providing relative motion between the carrier and the polishing surface to polish the surface of the substrate; and

enabling the polishing pad surface deformed under the retaining ring to partially rebound within the annular recess.

15 16. A method according claim 15, wherein the polishing surface comprises a pad of pliant material capable of being deformed by the retaining ring during the polishing operation, and wherein the step of pressing the lower surface of the retaining ring against the polishing surface comprises the step of reducing an area near an edge of the substrate having a lower polishing rate than a center of the substrate due to rebounding of the pad from a deformed condition in a first region near the inner edge of the retaining ring.

20 17. A substrate having a surface polished according to the method of claim 15.

25 18. A polishing head for positioning a substrate having a surface on a polishing surface of a polishing apparatus, the polishing head comprising:

a carrier;

a subcarrier carried by the carrier and adapted to hold the substrate during a polishing operation; and

30 a retaining ring disposed about the subcarrier and having a lower surface in contact with the polishing surface during the polishing operation, the retaining ring comprising a polymer to inhibit spalling of the lower surface during the polishing operation.

19. A polishing head according to claim 18, wherein the polymer is selected to provide an operating life for the retaining ring adequate for processing at least about 2,000 substrates.

5 20. A polishing head according to claim 18, wherein the retaining ring is made entirely or in part of a polymer selected from a group consisting of:

polyesters;
polyethylene terephthalate;
polyimide;
10 polyphenylene sulfide;
polyetherketone; and
polybenzimidazole.

15 21. A polishing head according to claim 18, wherein the lower surface of the retaining ring has at least one annular recess formed therein to inhibit non-planar polishing of the surface of the substrate.

20 22. A Chemical Mechanical Polishing (CMP) apparatus having a polishing head according to claim 18, the CMP apparatus further comprising:

a chemical dispensing mechanism adapted to dispense chemical onto the polishing surface during the polishing operation; and

a drive mechanism adapted to move the polishing head relative to the polishing surface during the polishing operation.

25 23. A retaining ring for use in a polishing apparatus, said retaining ring characterized in that said retaining ring includes:

first and second planar portions at inner and outer radial edges of said retaining ring; and

30 a concave substantially annular recess formed into a surface between said first and second planar portions and disposed to contact a resilient polishing pad during a polishing operation, said concave annular recess having a shape profile and a location such that a length of time during which the polishing pad is compressed by the retaining ring is reduced as compared to a retaining ring having a substantially planar surface.

24. Method for conditioning a polishing pad during polishing to reduce edge effects and rebound effects, said method comprising:

compressing said polishing pad by passing a first retaining ring portion over a leading edge thereof at a first pressure;

5 permitting at least a partial rebound of said polishing pad after said compressing of said polishing pad by reducing said pressure; and

recompressing said polishing pad after said at least a partial rebound by reapplying said first pressure.